e-ISSN : 26203502
p-ISSN : 26153785

Prospects for Receiving Paper from Agricultural Waste and Non-Wooden Alternative Materials

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Abstract: In this analytical article, the possibilities of using agricultural waste, non-wood and annual plants as a fibrous semi-finished product in the pulp and paper industry based on an analysis of the literature are examined. Scientific research conducted by scientists from around the world has been reviewed. The possibility of using alternative materials as raw materials in the paper industry was analyzed.

Keywords: cotton, wood, straw, anise, hemp, bamboo, waste paper, cellulose, hemicellulose, paper.

Introduction

It was reported by Euler Hermes experts that world paper production will reach 416 million in 2022. tons. Asian countries are the leaders in paper production, with an additional 7 million in 2022. tons of paper is expected to be produced. Nowadays, thick paper production is growing faster than printing and printing paper types, if before the pandemic 50% of the total paper produced was accounted for by thick paper, by 2022 it is expected to be two-thirds of the total paper. The volume of sanitary hygienic paper produced in the world remains stable, while the production of thick paper increased by 57% in 2019, but the production of writing and printing paper decreased by 26% during the same period. “Allianz Research. According to How paper and board are back on track, this situation will continue in 2022, and the volume of all types of thick paper will increase by 63%. For comparison, we can see that 17% of the paper produced is sanitary and 20% is printed paper. This is due to the high demand for thicker paper than plastic for packaging products due to rising global oil and gas prices [1].

However, increasing demand for paper and paper products could lead to a shortage of available wood stocks. In order to make up for this shortcoming, it is necessary to propose effective technologies for the use of non-woody plants in the production of paper types. The use of non-woody plants in the paper industry allows the development of environmentally safe alternative technologies for cellulose production.

Main part

The use of flax, hemp, cotton, straw, reeds and other plants in the paper industry has been studied extensively by scientists since the use of old rags in paper production, but the use of this raw material for other purposes has been studied in depth, and the first scientific work was published in 1768. At the that time, the effect of the above raw materials on the properties of paper, ie the length, toughness and amount of cellulose in the fiber, was studied, and scientifically based guidelines for the selection of raw materials in the production of paper types were given.

e-ISSN : 26203502
p-ISSN : 26153785

This is due to the fact that the world's reserves of agricultural waste are estimated at 998 million tons per year. When using 10% of it, it is possible to get 99.8 million tons of fiber semi-finished products per year for the production of paper and thick paper [2]. Sodium and sulphate boiling methods are proposed for the production of cellulose and semi-cellulose from annual and non-woody plants. Fiber semi-finished products from non-wood raw materials are widely used in the production of microcrystalline cellulose and cellulose esters in writing, printing, cigarettes, packaging, filtering, packaging, sanitary ware, box paper and thick paper, as well as in the chemical industry.

In recent years, the government has set a number of tasks to expand the range of paper products in the country, the localization of products. Comprehensive measures are being taken to develop the pulp and paper industry in different regions of the country. That is, on the basis of further expansion of industrial potential, efficient use of available resources, increase in employment and income of the population, the establishment of enterprises for the production of paper products in a number of regions. Moreover, the Decree of the President of the Republic of Uzbekistan No. PF-6244 of June 9, 2021 "On additional measures to increase the industrial potential of the regions" sets the task of creating an integrated system to promote the rapid development of a number of industries, including paper industry.

Fiber raw materials are sufficient in our country to obtain cellulose and paper from annual plants. These include licorice [3], tapinambur [4], amaranda [5], yucca [6], cotton stalks, rice stalks, and wheat straw. These are agricultural wastes. Some of the stalks are used as fodder for livestock, the rest is almost never used. Annual plant stems are actually the main fibrous raw material for chemical and cellulose-paper production. Abroad, these plants are widely used in the production of cellulose.

The use of non-wood raw materials in the production of paper and thick paper is one of the most cost-effective and environmentally friendly technologies. 44.40% of the plants used in the production of paper types are straw, 14.30% are reeds, 21.40% are bamboo and 14.30% are sugar cane. , 60% are other annuals or non-woody plants [7].

Among non-woody plants, a number of studies have been conducted on the extraction of cellulose from agricultural waste. The world produces about 2 billion tons of agricultural waste per year, including corn stalks, rice straw, sugar cane and wheat straw. And forest waste is estimated at 0.2 billion m^3 per year [8]. Currently, research on the development of alternative methods of obtaining cellulose using closed systems of processes is underway. Studies have shown that the yield of cellulose is 4-5% higher than that of wheat sulphate when boiled in alkaline (1.3-19.7% alkaline, 0-0.7% anthraquinone, boiling point 114^0C) sulphate method, the crystallinity is 2-3%. less, the boiling point is lower than 15-40^0C and the hardness of the resulting paper is 8-12% higher. Straw can also be used in the production of cellulose by the sodium method, two-stage oxygen alkaline method, combined boiling-bleaching processes, sulfate, neutral-sulfate and organosolvate-oxidation methods, and from it in the production of paper types. The organosalvate-oxidation method is promising in terms of its impact on the environment, in which the amount of cellulose formation is also higher than other methods. Persic acid, which is formed in the organo-solvate process, breaks down the lignin in annual plants, making it soluble, but does not affect the polysaccharides in the plant, ie the process of ligninization is selective.

The high content of hemicellulose and pentosones in the cellulose obtained from non-woody plants makes them highly cohesive. The relatively high adhesion of straw cellulose to cotton and wood cellulose is due not to the shape of these fibers, but to the high content of pentosans in straw cellulose [9]. Wheat straw has easy grinding properties, and the grinding rate increases rapidly. Straw cellulose fibers form a mass with a sufficiently high degree of grinding 300ShR, before it is yet milled. Basically, this type of cellulose is used in a composition of 15 to 60% with another type of cellulose [10]. In the production of thick paper by applying a semi-finished product mixed with urea-formaldehyde resin in cellulose obtained by processing in a two-screw

e-ISSN : 26203502
p-ISSN : 26153785

extruder at a temperature of 600C in an aqueous solution of 0.5% NaOH and 0.5% H_2SO_4, as well as 0.5% urea and 1.3% NaOH a number of positive results have been achieved [11].

Special attention is paid to the use of flax in the pulp and paper industry. The technology of production of semi-cellulose mass from flax by the sodium method has been developed. The problems of conversion of perennial herbaceous plants into fibrous semi-finished products and the possibility of obtaining products from flax with high content and α-cellulose [12] are shown in the study. The fiber length in the middle of the flax was found to be 0.5–0.6 mm, 20 μm in diameter, and 3–3.5 μm in wall thickness. The length of the fibers in the upper part of the plant is 20-28 mm, and its chemical composition consists of 35-40% cellulose, 20-30% lignin, 20-30% hemicellulose and 9-10% extractable substances.

The strength of laboratory paper samples obtained from cellulose obtained by treatment of non-woody Soranovsky type miscanthus with sodium hydroxide and nitric acid was evaluated and its possibility for use for sanitary paper was shown [13]. The use of non-woody plants in the paper industry depends on their composition, and scientists have studied the chemical composition of the annual medicinal, unbalanced plant Stipagrostis pungens, which grows in the arid regions of Tunisia. Experiments have shown that the plant contains a large amount of extractives, lignin up to 12%, polysaccharides up to 71%, α -cellulose 44%, ash content up to 4.65%. Lignocellulose fibers were obtained from the plant Stipagrostis pungens by the Natron-anthraquinone boiling method with a yield of about 43%. In the laboratory Rapid Khöten paper forming device paper samples with a surface density of 60 g/m^2 were formed and its physical and mechanical properties were analyzed. Experiments have shown that the high mechanical properties of the paper obtained from the plant Stipagrostis pungens can be used as an alternative material to wood cellulose in the production of paper [14].

It is known that cellulose, which is the main raw material of the paper industry, is produced mainly by sulfate and sulfite methods. Given the fact that both methods cause serious damage to the environment, it is important to create somewhat safe technologies for the production of cellulose from natural raw materials. One of the main directions in solving the above problems is the application of the Oganosolvat method in the production of smooth and corrugated layers of corrugated thick paper from chlorinated bleach obtained from hemp and sugar cane stalks. The study used a composition of unbleached organoslvate cellulose from non-woody plants and waste paper of the brand MS-5B for the production of thick paper weighing 175 g/m^2 and corrugated paper with 125 g/m^2. In this case, the degree of grinding of fibrous semi-finished products was 35 ± 2^{0}ShR, 2.5% of rosin glue was used for thick paper and 1.5% for corrugated paper. Analysis of the papers revealed that they correspond to the quality of similar products derived from sulfate wood cellulose [15].

Although not as durable as bamboo and acacia cellulose, it can be used in the production of flexible and stretchy paper types. This is due to the fact that the structural and morphological properties of bamboo and acacia cellulose obtained by the sulfate method differ from the properties of sulfate cellulose obtained from deciduous and coniferous tree species, ie the fibers are shorter and wider. When forming paper from a short-fiber mass, the fine fibers on the surface of the paper break or crumble, resulting in an increase in the dustiness of the paper. The paper obtained from eucalyptus-based cellulose was treated with KMTs to prevent the fibers from coming off the surface of the paper and crumbling when printed. It was found that fiber abrasion was significantly reduced when flowers were printed on these papers under laboratory conditions. It has been shown that when treated with KMTs, a parasitic structure is formed on the surface of the fibers, which strengthens the inter-fiber bonds [16].

Antibacterial paper production technology has been developed by Japanese scientists. Paper from 60% green tea leaves was used for the experiments. The paper is treated with x-ray lamp beams. The duration of irradiation is 1-200 hours. The amount of ultraviolet light is 6.67 106 Dj/m^2 at 365 mm. Optimal irradiation conditions for the production of high quality antibacterial paper have been proposed [17]. Bactericidal paper can also be used for food packaging. In this

e-ISSN : 26203502
p-ISSN : 26153785

regard, the effect of silver nanoparticles on the bactericidal and fungicidal properties of natural polymers containing cellulose and collagen derivatives was studied. A change in the structure of the material treated in the silver solution, i.e., the location and density of the microfibers, was determined. This new type of packaging material has high bactericidal properties, is not considered toxic, and does not harm the human body and the environment [18].

Like non-forestry countries, the development of the local pulp and paper industry through the effective use of non-timber perennials, agricultural and industrial wastes is of great importance in our country. In this regard, the use of licorice root waste in the pharmaceutical industry in the pulp and paper industry is important.

In the 2nd Appendix of the Resolution of the Cabinet of Ministers of February 15, 2019 No. 138 "On additional measures for the effective organization of cultivation and industrial processing of licorice and other medicinal plants", the forecast indicators for the establishment of new licorice plantations in the Republic of Karakalpakstan are set, according to which it is planned to grow licorice on 25,000 hectares per year. In a number of enterprises of the republic, medicinal syrup is extracted from the root of the red brain plant, which produces a large amount of red brain root waste per year. Of course, this allows the production of cellulose, semi-cellulose and mechanical mass from raw materials, as well as the production of technologies for the formation of paper types from their composition for various purposes.

Although the licorice plant, including its root, has been extensively studied, its waste has not yet been studied in depth, and has not found its application in production conditions. The results of scientific research on the use of waste as a fertilizer and as a food source for various fungi have been published. However, the relative ease of chemical processing of this waste, its low cost and the fact that it is 25-32% cellulose [19] allow it to be included in the list of fibrous raw materials in the pulp and paper industry. The main stage in the process of obtaining semi-finished cellulose products from fibrous raw materials is boiling. During boiling, lignin and hemicellulose are released from the tissue, while the cellulose remains almost unchanged. Factors influencing the process have been studied to develop the technology of the boiling process [20]. According to the results of experiments on the duration of the boiling process, the temperature and the effect of the concentration of chemical reagents on the quality of the obtained cellulose, it is recommended to carry out the process at a temperature of 150-1600C for 120 minutes in a solution of caustic alkali (60 g / l). . The resulting cellulose is yellowish-brown in color, and the bleaching process has been studied for its use in the production of household paper types. Studies have studied the factors influencing the bleaching process of anise root cellulose in hydrogen peroxide and sodium hypochlorite solutions in one- and two-step methods. According to the proposed technology, it is possible to obtain bleached anise root cellulose up to 60-70% whiteness [21]. The possibility of using licorice root cellulose in paper composition [22] was studied in the study, which concluded that in the production of writing paper it is possible to obtain a product that meets the standard requirements by adding 25% bleached licorice root cellulose to the composition. It was also reported in the study that the print properties of the newly proposed cellulose-added paper samples changed positively compared to the paper samples obtained from cotton cellulose [23]. Quality indicators of paper samples based on the composition of MS-1 brand waste paper, bleached cotton and licorice root cellulose, including whiteness, break length, smoothness were studied. According to the results of the study, up to 25% of licorice root cellulose can be added to the composition in the production of printed paper.

The use of not only non-woody plants but also textile fibers in the production of paper types has been mentioned in a number of studies, including the fact that the production of wrapping paper from technical cannabis waste is economically viable and meets its standard requirements. Hemp fiber has been used in the pulp and paper industry since 2000. This technology is lost and it is important to put it back on track. Experiments have shown that hemp fiber can be used instead of wood in the pulp and paper industry [24]. The stem of an annual hemp plant is 3.5-4 m long and 15-25 mm in diameter. The yield of hemp is 18-20 tons per year. The chemical composition of hemp is 50.5% cellulose, 20.3% lignin, 25.5% pentosans and 1.7-4.6% ash. The amount of

e-ISSN : 26203502
p-ISSN : 26153785

substances extracted under the influence of caustic alkali is 26.5%. Cannabis cut to a length of 10-30 mm is first ground in disc mills, then boiled for 90-150 minutes. The amount of cellulose formation is 51.2-63.6%, the breaking length is 8800-9800 m [25]. In an alkaline solution at a temperature of 700C containing hydrogen peroxide, even the suffocation of the untreated hemp stalk is faster than the suffocation of the wood shaft [26]. It has been shown that the sulphate method, which is widely used in the pulp and paper industry worldwide, can be used in the production of hemp cellulose. Extraction of cellulose from non-wood raw materials allows to make sanitary-hygienic paper from them, which does not require high strength.

Fiber waste from the textile industry has a special place in paper technology. Positive results have been achieved in the production of printed paper on the basis of textile fibers and cotton cellulose belonging to different classes. In the printing industry, the printing properties of multilayer paper and thick paper containing synthetic fibers for printing packaging products have been studied. For the printing industry, the technology of making multi-layer composite packaging and thick paper using cotton cellulose and synthetic fibers and the rational composition of the paper mass have been proposed. A composition was developed for the preparation of multilayer wrapping paper using secondary fibrous materials and polymer adhesives [27].

The presence of synthetic fibers in the composition of the paper has a positive effect on a number of their properties. The paper is composed of a composition containing nitron fibers (PAN) modified with a solution of cotton cellulose and natural silk waste, and its compliance with the standard requirements for multi-color offset printing paper has been demonstrated on the basis of scientific studies. The study of the physico-mechanical and printing properties of the paper in this composition showed the possibility of saving wood pulp, which is in short supply in their production [28]. Increasing the proportion of modified PAN fibers in the composition by more than 20% can reduce the mechanical strength of the paper to 12%. However, the strength achieved (3602 m) is higher than the demand for offset printing paper (200-2500 m). Nitron fiber modifier - hydrogen and covalent bonds are formed between the fiber and the modifier due to the different functional groups in the natural silk macromolecule. The fact that the natural silk macromolecule is a cross-linking component of synthetic fiber and cellulose, the formation of new intermolecular bonds [29] is based on IR-spectroscopic analysis in the study. The possibility of using not only PAN, but also polyfiber fibers in the composition of paper has been studied. It has been reported in the study that the mechanical properties of the product can be improved by adding polyester fibers to the paper mass in the production of various fibrous composite materials, including paper [30].

X. Alimova's schools have conducted research on the development of waste-free technology of natural silk, which offers effective technologies for use in the production of valuable types of paper from natural silk waste. The possibility of forming a paper protected from a composition containing natural silk fibers is scientifically based [31, 32]. In the production of silk fabrics, textile enterprises produce silk waste containing about 10% of long fibers. Adding 40% of silk waste to the paper mass leads to improved mechanical properties of the paper, increased shear resistance, reduced production costs. Kamalova S.R. The composition of the paper based on PAN fibers dyed with special cationic dyes with the wastes of silk spinning mills was reported by. Flowers were digitized on paper of new fiber content and the coloristic values of the resulting colors were determined [33].

Conclusion

It is concluded according to the analyzed literature that special attention was paid to the prospects of using plants as an alternative to wood in the pulp and paper industry. The analysis showed that scientific research is being conducted to study the possibility of using fibrous semi-finished products from annual and perennial herbaceous plants, forest waste and textile waste in the production of paper types. The studied sources show that wood cellulose can be used not only in the production of thick paper, but also in the production of printed and writing paper, as

e-ISSN : 26203502
p-ISSN : 26153785

well as household-hygienic paper. From the analysis of the literature we can see that in non-forestry countries through the production of fibrous semi-finished products from existing plant species and industrial wastes can not only localize paper and paper products, but also preserve the environment in the country.

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